C E Composites-04.US

Schedule B
to the Response of June 27, 2005 Serial number 10/672,060

Revisions to text of the Disclosure

SUMMARY OF THE INVENTION

[0016] Therefore, in view of the foregoing, what is needed is tubular baseball bats with **a specific distribution of** variable stiffness along their barrel portions. A main object of the present invention is to provide tubular baseball **bats**, and particularly existing bats, with changed (usually decreased) bat performance, without significantly increased weight, in order to meet new or changed performance standards. To achieve this, the bats of the present invention are stiffened in the barrel area[,] of peak bat performance commonly referred to as the sweetspot. Typically, this is an area approximately 2" to 4" in width as compared to barrel portion lengths of 4" to 16". **One basic feature of the invention is to increase the radial stiffness of the barrel wall in the mid-section region of the barrel portion of the bat over the radial stiffness in the two adjacent regions okay. This may be done in a variety of manners. These include:**

- by forming the barrel wall of inherently stiffer material within the mid-section,

- by making the barrel wall thicker within the mid-section, or

- by providing a stiffener within the mid-section of the barrel, either on the inside or on the outside barrel wall surface. ~~**This is achieved by inserting or adding to the bat a circumferential stiffner in the region of the sweetspot.**~~

[0017] **According to one variant, a** ~~**The preferred**~~ short, light weight, polymer composite circumferential stiffener **of the invention as** employed adds only minimal weight to a given bat thus allowing the stiffened bat to be continued to be used within the required weight requirements of baseball. The stiffener of the present invention can be added to used bats returned from players for modification to meet a changed regulation and also can be added to bats manufactured before a regulation change occurs, allowing such previously manufactured bats to meet a changed standard. Though somewhat heavier, a short metallic stiffener could also be employed. An alternative solution of the present invention to vary stiffness, and thus bat performance, along the barrel portion is to vary thickness along the barrel portion.

[0018] A second object of the present invention is to provide tubular bats with bat performance decreased to meet a given changed regulation in a precisely controlled manner; that is, if the standard requires a standard of x maximum and a given bat design has a performance greater than x, then following the precisely located stiffening, the bat performance will meet the x requirement and not be significantly less than x. In the present invention, this is accomplished by ~~**engineering calculations considering**~~ selection of the composite fiber type, the fiber size, the angles of the fibers, and the thickness of the polymer composite stiffener to be employed, ~~**directed**~~ to precisely

lower the bat performance. Proper engineering design of these variables of a polymer composite results in a polymer composite stiffener which when added to a tubular bat results in that bat precisely meeting the desired new bat performance.

[0019] A third object of the present invention is to provide existing tubular bats with a specific predetermined bat maximum bat performance with a larger sweetspot than tubular bats of the prior art. In the present invention this is accomplished by precisely stiffening only the peak performance area (generally the sweetspot area) of the existing bat to the performance level of the barrel portion areas immediately adjacent on both sides of the sweetspot of the unstiffened bat. The resultant effect ~~is~~ can be to approximately double the sweetspot size (that is, the area of the barrel portion which provides maximum bat performance).

[0020] A fourth object of the present invention is to provide newly designed tubular all polymer composite baseball bats with a predetermined bat performance with larger sweetspot areas than bats of the prior art. In the present invention this ~~is~~ may be accomplished by graduating the radial stiffness of the barrel wall ~~portion~~ along the entire barrel length. Specifically, the peak performance area (generally the sweetspot area) is designed to have ~~the highest~~ a higher local radial stiffness while the ~~area~~ two lateral regions of the barrel portion on either side of the mid-section region, nearer ~~nearest~~ the taper and barrel ends have ~~the lowest~~ a lower relative radial stiffness, ~~and with~~ the stiffness of the barrel wall along the barrel portion between the sweetspot and barrel ends being graduated. The resultant effect can be ~~is~~ a sweetspot area that runs substantially through the full length of the midsection of the barrel portion. In the present invention this is accomplished by engineered selection of the composite fiber type(s), fiber sizes(s), fiber angles(s), and the total composite multi-layered laminate or structure having graduated radial stiffness along the barrel portion length.

DETAILED DESCRIPTION OF THE INVENTION

[0045] The present invention is directed to providing tubular baseball bats with bat performance decreased in a controlled manner, to meet changing regulatory standards, without significantly increasing bat weight (Fig. 4, 5, 6, 7 and 8). Further, such decreased bat performance can be achieved in a simple manner at reasonably low costs and applied to both bats being manufactured or returned from end users. Further, such bats of the present invention can have a larger sweetspot size.

[0046] The prior art bats are shown in Figs. 1, 2, and 3. Fig. 1 shows a single wall tubular bat with main member 16. Fig 2 shows a double wall tubular bat with an insert 13, formed separately from the main member 16, which is fitted into the entire barrel length 1 of the main member 16. Fig. 3 shows a double wall tubular bat with a sleeve 14, formed separately from the main member 16, which is fitted over the entire barrel length 1 of the main member 16.

[0047] Though not indicated in Figs. 1 through 8, bats of the present invention, as do bats of the

prior art, include a traditional knob (not shown in the drawings) at the handle portion end 5, **or proximal end of the bat,** and a traditional end cap (not shown in the drawings) at the barrel portion end 4, **the distal end**, both of which can be made from a variety of materials.

[0048] Most adult tubular baseball bats of the prior art have maximum outside barrel portion diameter 2 either 2.625 or 2.75 inches. Depending on the taper portion geometry of the mid-section 8, and the total length of the bat, the barrel length 1 as defined by length of constant maximum diameter 2, ranges from 4 to 12 inches. Barrel wall thickness 6 ranges from .100 inches to .140 inches for aluminum bats and up to .220 inches for all composite bats.

[0049] Most youth baseball bats and softball bats of the prior art have maximum outside barrel portion diameter 2 of 2.25 inches. Depending on the taper portion geometry of the mid-section 8, the barrel length 1 ranges from 4 to 16 inches. Barrel wall thickness 6 ranges from .060 to .090 inches for aluminum bats and up to .220 inches for all composite bats.

[0050] The bats of the present invention, shown in Figs. 4, 5, 6, 7 and 8 have similar dimensions to the foregoing prior art bats shown in Figs. 1, 2 and 3.

[0051] A first embodiment of the present invention Fig. 4 is a single wall tubular baseball bat consisting of a cylindrical handle portion 7 for gripping, a cylindrical tubular barrel portion 9 for striking or hitting, and a tapered ~~**mid-section**~~ **portion** 8 connecting the handle 7 and barrel 9 portions, with a thin polymer composite stiffener 18 **having a stiffener wall** located internally within the barrel portion 9 and extending longitudinally in the **mid-section,** sweetspot area 19 of the barrel length 1.

[0052] A polymer composite is a non-homogenous material consisting of continuous fibers embedded in, and wetted by, a polymeric resin matrix whereby the properties of the material are superior to those of its constituent fibers and resin taken separately. Such polymer composites are anistropic materials since they exhibit different responses to stresses applied in different directions depending on how the fibers are aligned or angled within the matrix.

[0053] Other materials commonly used in bat constructions such as aluminum, wood and plastics are not anistropic and are thus limited in controlling bat performance; for example, radial stiffness is equal to longitudinal stiffness and cannot be graduated along the barrel length 1. However, with composite materials, which are preferred, properties of bats made in accordance with the present invention, such as radial stiffness which determines bat performance can be controlled (i.e. designed to a given requirement) by altering such parameters as the fiber alignments along the bat length 1, and/or the type of fibers chosen, their dernier or layout density and/or the thickness of the polymer composite structure.

[0054] Generally, the fiber materials used are selected from a group consisting of fiberglass, graphite

or carbon, aramid, boron, nylon, or hybrids of any of the foregoing, all of which are commercially available. The resins used to impregnate, wet out, and encapsulate or imbed the fiber materials are generally selected from a group consisting of epoxy, polyester, vinyl ester, urethane, or a thermoplastic such as nylon, or mixtures thereof.

[0055] The first embodiment Fig. 4 of the present invention consists of a thin polymer composite stiffener 18 located internally within the barrel portion 9 generally in the sweetspot area 19 located in proximity to the middle or mid-section area of the barrel length 1 of a single wall tubular bat. The resultant stiffened bat results in a predetermined calculated lower performance, with a bigger (longer) sweetspot 19, as subsequently explained.

[0056] The sweetspot area 19 of a baseball bat is generally referred to as that area along the barrel length 1 in which bat performance is greatest; that is, a ball struck within the sweetspot area 19 will travel further than a ball struck on either side of the sweetspot area. Typically, the sweetspot area 19 is located around the middle of the barrel length 1 and is in the order of 2[″] **inch** to 4[″] **inch** in length as compared to barrel lengths 1 ranging from approximately 4[″] **inch** to 16[″] **inch** or more.

[0057] In actual practice, the performance of a baseball bat of the prior art follows a statistical normal distribution along the barrel length 1, usually centered near the middle of the barrel length 1 in the sweetspot area ~~9~~ **19**. Figure 9 shows a typical bat performance distribution example with a 12[″] **inch** barrel length 1.

[0058] In Figure 9, the maximum bbs (one measure of bat performance standard) is 100 while most players would describe the sweetspot as being approximately 2[″] **inch** long (that is, the portion of the barrel length equal to or greater than 98 bbs). The bat of this particular sample meets a bat performance factor standard of 100 bbs maximum if so regulated.

[0059] If the applicable regulatory body for the bat in the Figure 9 example changed the bat performance standard from 100 bbs maximum to say 96 bbs maximum, the bat of the present invention **could be provided** with a specifically designed 4[″] **inch** polymer composite stiffener 18 located in the center of the barrel length 1. Figure 10 shows the bbs versus barrel length for this example.

[0060] In Figure 10, in an example of the present invention, **the combined barrel wall, with** the polymer composite stiffener 18 **present,** is approximately twice as stiff in the center 2[″] **inches** of the sweetspot area 19 as in the 1[″] **inch** area immediately adjacent to the center **or mid-section** area on each side of the center area. The polymer composite stiffener 18 fiber type, fiber angles and thicknesses are designed such as to reduce the bbs from 100 to 96 in the center ~~area~~ 2[″] **inch area** of the barrel length 1 and from 98 to 96 bbs in the 1 [″] **inch** areas immediately adjacent to the center area. As a result of the present invention, the resultant typical example bat meets the lowered regulatory standard of 96 bbs with a sweetspot area 19 which has been increased by 100% (from 2[″]

inch wide to 4[″] inch wide).

[0061] The first embodiment (ie. internal stiffener 18) of the present invention is particularly suited to retrofitting used bats returned by players and making legally playable under a revised standard.

[0062] The thin polymer composite stiffener 18 of the present invention has a stiffener wall which is typically in the order of .005[″] inches to .040[″] inches in thickness, ~~thick~~ with a length of 2[″] inches to 6[″] inches which is typically less than 50% of the barrel length, such as 16 2/3 % of the barrel length, as is apparent from Figure 10. A 4 inch stiffener, as referenced in paragraph [0059], in a 12 inch barrel as referenced in Figure 10, would represent 33.3% of the barrel length; a 4 inch stiffner in a 16 inch barrel would represent 25%, and a 2 inch stiffner in a 16 inch barrel would represent 12.5% of the barrel length. ~~and~~ The stiffener 18 is preferably bonded, fully or partially, to the main member 16, or to the secondary member insert 13 of Fig. 7 or to the secondary member sleeve 14 of Fig. 8, or combinations thereof on either the internal or external barrel walls, as shown in Figures 4, 5, 7 and 8. ~~Though not shown~~ Analogous to Figures 4, 5, 7 and 8 an alternative solution (since stiffness is proportional to thickness) to the stiffener 18 is to vary the barrel thickness 6 along any portion of the barrel length 1~~, either full length or any mid-section portion of the barrel length 1~~ in order to vary bat performance. The barrel portion's effective wall thickness in the mid-section can be greater by 5% over the thickness of the barrel in the lateral, adjacent portions. Conversely, the barrel wall's thickness beyond its central portion, in the lateral regions proceeding towards the end portions of the barrel, may be at least 5% thinner than the thickness of the barrel wall in the mid-section.

[0063] A second embodiment of the present invention Fig. 5 is a single wall tubular baseball bat which in accordance with the present invention has a thin polymer composite stiffener 18 located externally to the barrel portion 9 generally in the sweetspot area 19 located in proximity to the middle area of the barrel length 1. The resultant stiffened bat results in a calculated lower performance, with a bigger (longer) sweetspot 19, as previously explained.

[0064] A third embodiment of the present invention Fig. 6 is a single wall tubular polymer composite baseball bat which in accordance with the present invention has a localized area of fiber type and/or angle change 20 resulting in increased radial stiffness generally in the sweetspot area 19 located in proximity to the middle area of the barrel length 1. ~~Though not shown, t~~ This embodiment applies equally well to double-wall and multi-wall (more than two walls) tubular all polymer composite baseball bats and is limited to newly designed polymer composite single wall, double-wall, and multi-walled new bats as opposed to field returned bats. ~~Though not shown, the~~ The fiber types, and/or fiber angles, and/or fiber sizes, and/or composite thickness can be designed such as to graduate the radial stiffness of the barrel wall within the barrel portion 1 along its entire length. That is, the radial stiffness could be highest in the peak performance area (generally the sweetspot area 19) and gradually changing in uniform increments proceeding towards the barrel

ends~~, where the radial stiffness would be lowest~~. ~~The resultant effect is a sweetspot area 19 that extends substantially full length of the barrel portion 1.~~

[0065] A fourth embodiment of the present invention Fig. 7 is a double-wall tubular bat showing two separate members, a frame or main member 16 with an internal insert 13 as a secondary member full length in the barrel length 1 and, in accordance with the present invention, a stiffener 18 located internally within the insert 13 generally confined to the sweetspot area 19, along the barrel length 1. Though not shown, the stiffener 18 could be located externally to the main member 16 or between the main member 16 and the internal insert 13. Also, though not shown, in multi-walled bats the stiffener 18 could be located internally, or externally, or between the members, or combinations thereof.

[0066] A fifth embodiment of the present invention Fig. 8 is a double-wall tubular bat showing two separate members, a frame or main member 16 with an external sleeve 14 as a secondary member full length in the barrel length 1 [,] and, in accordance with the present invention, ~~has~~ a stiffener 18, located externally to the sleeve 14, generally in the area of the sweetspot area 19 along the barrel length 1. Though not shown, the stiffener 18 could be located internally to the main member 16 and the external sleeve 14. Also, though not shown, in multi-walled bats, the stiffener 18 could be located internally, or externally, or between the members, or combinations thereof.

[0067] The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiments are therefore to be considered as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes that come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.